

RAILROAD ACCIDENT INVESTIGATION

REPORT NO. 4179

T. E. R.

MAY 30 1972

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SOUTHERN PACIFIC TRANSPORTATION COMPANY

TRUCKEE, CALIF.

R. R. G. APRIL 22, 1971

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C. W. S.

FEDERAL RAILROAD ADMINISTRATION

OFFICE OF SAFETY

Washington, D. C. 20590

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Summary

DATE: April 22, 1971

RAILROAD: Southern Pacific

LOCATION: Truckee, Calif.

ACCIDENT TYPE: Derailment

TRAIN INVOLVED: Freight

TRAIN NUMBER: Extra 8946 East

LOCOMOTIVE NUMBERS: Diesel-electric units 8946, 8839, 8905, 8885

CONSIST: 89 cars, caboose

SPEED: Undetermined (high speed)

OPERATION: Signal indications

TRACKS: Double; 6°45' curve; 1.48% descending grade eastward

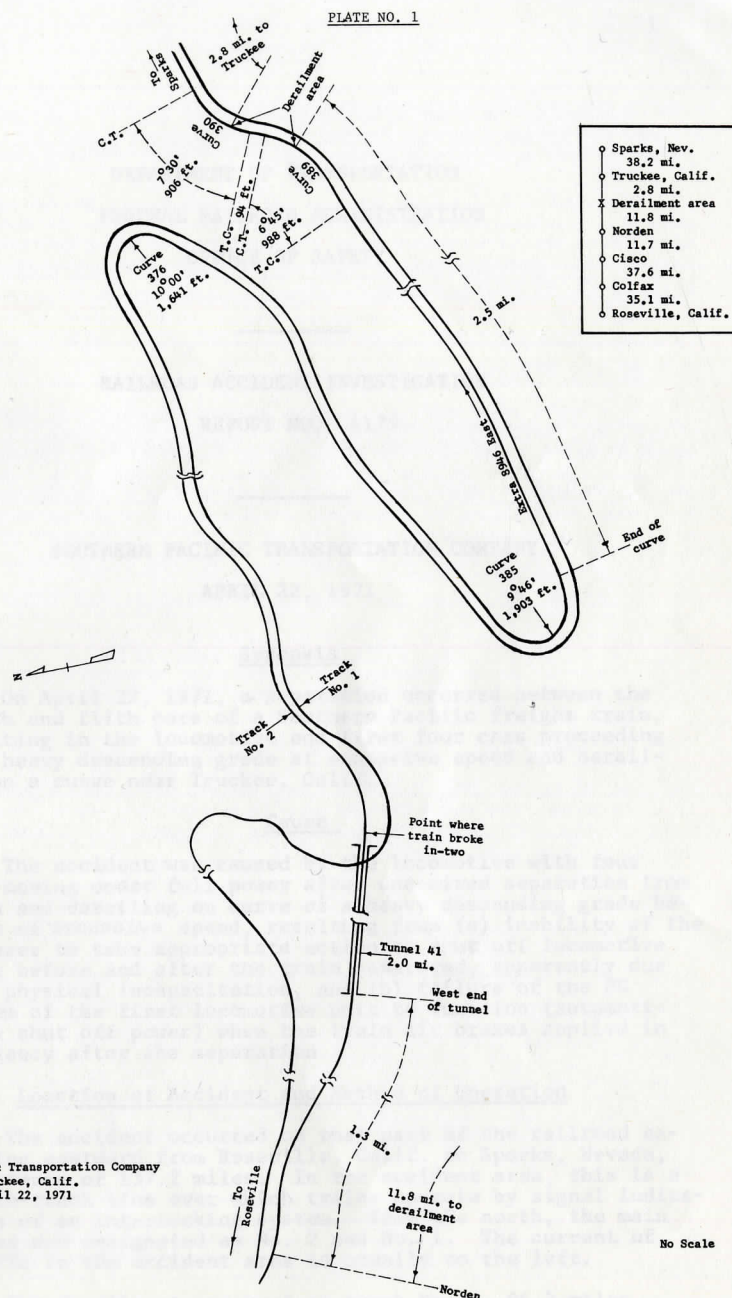
WEATHER: Cloudy

TIME: 8:45 p.m.

CASUALTIES: 1 killed; 1 injured

CAUSE: Locomotive with four cars moving under full power after undesired separation from train and derailing on curve of a heavy descending grade because of excessive speed, resulting from (a) inability of the engineer to take appropriate action to shut off locomotive power before and after the train separated, apparently due to a physical incapacitation, and (b) failure of the PC system of the first locomotive unit to function (automatically shut off power) when the train air brakes applied in emergency after the separation.

Southern Pacific Transportation Company
Truckee, Calif.
April 22, 1971



DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION
OFFICE OF SAFETY

RAILROAD ACCIDENT INVESTIGATION
REPORT NO. 4179

SOUTHERN PACIFIC TRANSPORTATION COMPANY
APRIL 22, 1971

Synopsis

On April 22, 1971, a separation occurred between the fourth and fifth cars of a Southern Pacific freight train, resulting in the locomotive and first four cars proceeding on a heavy descending grade at excessive speed and derailling on a curve near Truckee, Calif.

Cause

The accident was caused by the locomotive with four cars moving under full power after undesired separation from train and derailling on curve of a heavy descending grade because of excessive speed, resulting from (a) inability of the engineer to take appropriate action to shut off locomotive power before and after the train separated, apparently due to a physical incapacitation, and (b) failure of the PC system of the first locomotive unit to function (automatically shut off power) when the train air brakes applied in emergency after the separation.

Location of Accident and Method of Operation

The accident occurred on that part of the railroad extending eastward from Roseville, Calif. to Sparks, Nevada, a distance of 137.2 miles. In the accident area, this is a double-track line over which trains operate by signal indications of an interlocking system. From the north, the main tracks are designated as No. 2 and No. 1. The current of traffic in the accident area is usually to the left.

The derailment occurred on track No. 2, 96.2 miles east of Roseville and 2.8 miles west of Truckee.

Norden is 14.6 miles west of Truckee and 11.8 miles west of the derailment area. It is at the summit of the railroad grade in the Sierra Nevada Mountains.

Beginning 1.3 miles east of the station at Norden and ending 2.0 miles farther eastward, track No. 2 is in Tunnel 41. Track No. 1 crosses over the top of the east portal of Tunnel 41. Between that portal and Norden, it is on the north side of track No. 2.

Track

Curves and Tangents

Eastward on track No. 2 from Norden there are a few curves and tangents to Tunnel 41. The track is tangent through the tunnel and for a distance of 1400 feet beyond the east portal. Following this tangent, there is a series of relatively slight curves and tangents 3.1 miles eastward to Curve 376, which is a compound 1641-foot curve to the right having a maximum curvature of $10^{\circ}00'$. Eastward from Curve 376, there is another series of tangents and relatively slight curves to Curve 385, a distance of 1.9 miles. Curve 385 is 1903 feet long and has a curvature of $9^{\circ}46'$ to the left. Eastward from that curve there are, successively, a tangent 1.1 miles in length; a series of curves and tangents 1.3 miles; a $6^{\circ}45'$ curve (Curve 389) to the left 988 feet; a tangent 94 feet, and a $7^{\circ}30'$ curve (Curve 390) to the right 906 feet.

The derailment occurred on track No. 2, in an area encompassing the easterly portion of Curve 389, the westerly portion of Curve 390, and the intervening 94-foot tangent. In this area, the main tracks are in a sidehill cut. The wall of the cut is on the south side of track No. 1 and a few feet from that track.

Grade

Eastward from the Norden station the grade of track No. 2 is, successively, level 4323 feet; 0.20% descending 2042 feet; 1.47% descending (through Tunnel 41) 2.3 miles, and 0.14% descending to a point about 2850 feet beyond the east portal of Tunnel 41. Eastward from that point, the grade varies between 1.24 and 2.02% descending 5.0 miles to Curve 385. It is 1.20% descending through that curve, and varies between 0.48 and 1.24% descending throughout a distance of 1.9 miles farther eastward. The grade eastward is then 1.66% descending 2890 feet; 1.92% descending 570 feet, and 1.48% descending 200 feet to the derailment area and a short distance beyond.

Time and Weather

The derailment took place at 8:45 p.m., under cloudy and near freezing weather conditions.

Authorized Speed

The maximum authorized speed for the train involved was 30 m.p.h. in the Norden-Truckee area.

Train Equipment

The train consisted of road-switcher type diesel-electric units 8946, 8839, 8905 and 8885, coupled in multiple-unit control, 89 cars and a caboose (5128 tons). Each locomotive unit was an EMD SD-45 model, rated at 3600 horsepower. The first unit (8946) was built in 1968; the three trailing units in 1966 and 1967. Each had 26L air brake equipment; dynamic brake equipment with the extended range feature for continued effectiveness at slow speed; two-stage air compressors having a capacity of 401 cubic feet per minute at 900 RPM; six-wheel trucks; composition brake shoes, and a single brake shoe for each wheel.

The control stand in the cab of the first unit was similar to those in the three trailing units. It was provided with three levers, as follows:

- (a) Reverser, for controlling the direction.
- (b) Selector, for operating the locomotive under power or dynamic braking. This lever has six positions. From the left, they are "B" for dynamic braking; "Off," and 1, 2, 3, 4 for power. The position that the selector lever is in is indicated by an indicator behind an illuminated window in the panel of the control stand.
- (c) Throttle, for regulating speed.

All four units were equipped for fully automatic transition. Hence, for operation under power it made no difference whether the selector lever was placed in No. 1, 2, 3 or 4 power position.

After it is moved in either direction, the spring-loaded selector lever returns to center. When going from power to dynamic braking, the engineer is required by the carrier's instructions to (1) assure that the throttle is in "Idle" position (2) move the selector lever to "Off" position (3) pause 10 seconds (4) move the selector lever to "B" position, and (5) use the throttle to control the amount of dynamic braking. In moving the selector lever from power position to "Off" position, the engineer must move it to the left the same number of times as the number of the power position it was in.

The throttle has ten positions, "Stop," "Idle" and 1 to 8 inclusive. The engineer may stop all the engines of a locomotive by moving the throttle to "Idle," pulling the throttle lever outward from the control stand, and then moving it beyond "Idle" to "Stop" position.

The throttle is also used to control application of the dynamic brake when the selector lever is in "B" position. Braking effort may be increased by slowly advancing the throttle to the full 8th position if desired. When so used, the throttle moves smoothly. It moves in notches when the selector lever is in other than "B" position for dynamic braking.

The engineman of the train involved had one way to stop all the engines of the locomotive without leaving the cab of the first unit. It was as follows:

1. Move the throttle to "Stop" position as described in the foregoing.

In addition, the engineman had the following two ways to shut off power on all the units without leaving the cab:

1. Move the throttle to "Idle" position.
2. Move the generator field switch on the panel of control stand to "Off" position.

The first locomotive unit, as well as the three trailing units, was provided with a dynamic brake interlock feature and a PC (Pneumatic Control) switch.

The dynamic brake interlock feature is designed to prevent the automatic service brake from applying on the locomotive when the dynamic brake is in use.

The PC switch is designed to automatically shut off power (reduce all diesel engine speeds to "Idle") when an emergency brake application occurs.

The locomotive manufacturer's Operator's Manual cautions that the engine run switch of each trailing unit should be placed in the "Off" position to avoid the possibility of the PC switch of the first unit not acting to reduce engine speeds to "Idle" after an emergency brake application occurs. All four units had been modified in such manner that removal of the reverser lever on a trailing unit should prevent any improperly positioned switch on that unit from having an adverse affect on control of the locomotive from the cab of the first unit.

Circumstances Prior to Accident

Extra 8839 East, an eastbound freight train consisting of 3 diesel-electric units, 78 cars, a helper locomotive, 11 cars and a caboose, in that order, left Roseville at 3:20 p.m. the day of the accident after having had the prescribed brake test.

The train proceeded on an ascending grade to Colfax, 35.1 miles east of Roseville, where it stopped to pick up diesel-electric unit 8946 from an auxiliary track. The road engineer and front brakeman then moved unit 8946 from the auxiliary track and coupled it to the front of their train, making that unit the lead unit of the road locomotive.

After this was accomplished, the front brakeman coupled the air and control hoses between unit 8946 and the second unit (8839). Meanwhile, the engineer apparently connected a jumper cable between those units and positioned their controls for operation of the road locomotive in multiple-unit control from the cab of the first unit (8946). Soon afterward, when its brakes had been applied and released for a test, the train, now operating as Extra 8946 East, left Colfax.

As Extra 8946 East moved in the vicinity of Cisco, 37.6 miles east of Colfax, the engineer applied the air brakes for the running brake test required nearing the summit of the ascending grade. The brakes were then released and the train continued eastward toward Norden, 11.7 miles east of Cisco. At 8:10 p.m., after reaching the summit of the railroad grade in the Sierra Nevada Mountains, the road engineer stopped the train on track No. 2 at Norden, and the helper locomotive was removed from between the 78th and 79th cars. The road locomotive pushed the front portion of the train backward to a coupling with the rear portion, reassembling the train. The brakes of the train were then applied and released for a test. Upon seeing that the caboose air gage indicated brake pipe pressure had been restored to between 75 and 80 pounds, the conductor instructed the engineer by radio to proceed.

Extra 8946 East began to leave Norden on track No. 2 at 8:20 p.m. The engineer and front brakeman were in the cab at the front of the first locomotive unit. The conductor, swing brakeman, and flagman were in the caboose. The front brakeman said he had conversed frequently with the engineer while en route from Roseville and had noticed nothing abnormal about his condition or appearance, except for some loss in weight since the last time they had worked together.

The Accident

Soon after it left Norden, Extra 8946 East neared Tunnel 41 and the 1.47% descending grade extending through the tunnel. The crew members in the caboose said the train approached the aforesaid tunnel and grade at normal speed (apparently 20-25 m.p.h.). However, shortly after the caboose moved into the tunnel, the conductor felt the train was "moving a little too fast." He then looked at the caboose air gage and saw that the engineer had just initiated a heavy service application of the brakes. Soon afterward, according to the conductor, swing brakeman and flagman, the caboose came to a smooth stop in the tunnel and the train air brakes applied in emergency immediately thereafter. Later, upon realizing that brake pipe pressure was not being restored, they proceeded forward alongside the train to determine the cause of the emergency brake application and saw nothing unusual until they reached the fifth head car, which was stopped about 1500 feet outside the east end of the tunnel. There they saw that the locomotive and first four cars were missing, and found part of a broken sliding sill and the drawbar from the front of the fifth car lying between the rails directly below the front end of that car. The uncoupling lever was still attached to the coupler of the drawbar and to a

bracket at the front of the car. No dragging marks were found on the track structure, indicating that the broken off part of the sliding sill had dropped, along with the drawbar, between the rails after the fifth and following cars in the train stopped on track No. 2.

The conductor, swing brakeman, and flagman removed the broken-off draft gear from the track structure. Then, assuming the locomotive had taken the first four cars to Truckee and would return to the train to move the disabled fifth car by use of a chain, they began to await the locomotive. Approximately two hours later, a passing track-motorcar operator informed them that the locomotive and first four cars had derailed on a curve some distance eastward.

The evidence is that as the train stopped with its rear end in Tunnel 41, a separation occurred between the fourth and fifth cars, causing the train brakes to apply in emergency, including those of the locomotive and first four cars. Under these circumstances, the PC switch of the first locomotive unit should have functioned in such manner as to automatically reduce the speed of all engines in the locomotive consist to "Idle." This apparently did not occur, however, resulting in the locomotive and first four cars proceeding eastward on the descending grade under sufficient locomotive power to overcome the retardation effort of the emergency brake application. The engineer, who was killed in the accident, apparently did not take the appropriate action necessary to reduce or shut off power after the PC switch did not do so automatically.

The front brakeman stated that while the train was leaving Norden on the level grade there, the engineer applied power and increased speed to about 20 or 25 m.p.h. He further stated that the train entered Tunnel 41 at normal speed, but then increased speed above normal. As the locomotive moved in the tunnel, the front brakeman heard a clicking noise emanating from electrical equipment in the cab of the first unit. At first he thought this was caused by the engineer having initiated dynamic braking action. Shortly afterward, however, he assumed the locomotive was not in dynamic braking but was still under power, due to (1) hearing the locomotive's engines increase speed (2) noticing an increase in train speed, and (3) not hearing the distinctive sound produced by a locomotive under dynamic braking.

The front brakeman does not recall having heard the exhaust of air from the service brake application which resulted in the train stopping after partially emerging from Tunnel 41. He also does not recall the train having stopped. It was his recollection (apparently erroneous) that the train brakes were applied in emergency as the locomotive moved in the vicinity of the east portal of the tunnel, and that the train did not thereafter reduce speed, but accelerated instead and emerged from the tunnel while moving at a speed of 40 or 45 m.p.h. and accelerating on the descending grade. The front brakeman said he remained in his seat on the left side of the cab for some time, not knowing what to do and becoming increasingly alarmed, as the locomotive and what he

thought was the entire train seemed to be accelerating on the descending grade even though the air brakes were applied in emergency. He said that he eventually arose from his seat and left the cab via the door behind the engineer's position, without having exchanged any words with the engineer who was seen to be manipulating controls of the locomotive. After leaving the cab, the front brakeman proceeded to the rear of the first locomotive unit and boarded the front of the second unit. While doing so, he noticed fire flying from under the locomotive due to heavy braking action. He said that he was not certain about what he intended to do on the second unit, because of being convinced at the time that the train was intact and moving out of control on the descending grade even though its brakes had been applied in emergency.

Immediately after he boarded the second unit, the front brakeman decided to return to the first unit and talk to the engineer. After stepping back onto the rear of the first unit, he realized the locomotive was nearing a tunnel at Curve 375, which has a curvature of 10°00' to the right. Fearing the locomotive could not negotiate Curve 376 without derailling in the tunnel, the front brakeman decided to jump from the first unit. He did so shortly before the locomotive entered Curve 376.

The locomotive with four cars, moving under power and with the brakes applied in emergency, negotiated Curve 376 without derailling. Approximately two minutes later, Curve 385 (a 9°46' curve to the left) was also negotiated without derailling, indicating the emergency brake application was still somewhat effective in retarding acceleration of the locomotive and four cars on the heavy descending grade. Soon after moving through Curve 385, however, the locomotive and four cars evidently began to increase their rate of acceleration, due to deterioration of the brake shoes by heavy braking action over a considerable distance. After increasing speed considerably, the locomotive and four cars entered a 6°45' curve to the left (Curve 389). While moving on the east portion of that curve at excessive speed, the last three cars, which were loaded box cars, overturned to the right, resulting in derailment of the first car, an empty tank car, and the four locomotive units in the area encompassing the east end of Curve 389, the west end of Curve 390, and the intervening 94-foot tangent, about 8.2 miles east of the point where the locomotive and four cars separated from the train.

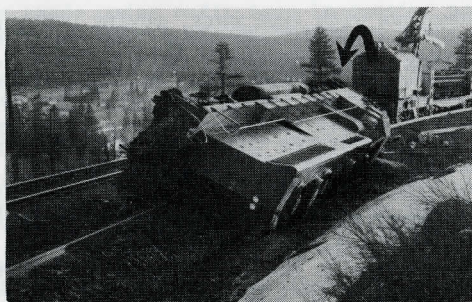
Damages

The fourth car, a box car loaded with mixed food products, overturned to the right on track No. 2, 507 feet east of the west end of Curve 389. It stopped on its right side, adjacent to and in line with the south side of track No. 1, 220 feet short of the east end of Curve 389.

The third car, a box car loaded with dry fruit, overturned to the right on track No. 2 and stopped on its right side, adjacent to and in line with the south side of track No. 1, 75 feet short of the east end of Curve 389.



Track No. 2 at left. Arrow points to 4th locomotive unit and first car. Remaining 3 derailed cars are along hillside. Fourth car overturned from track No. 2 outside of left of photo, at a point about 100 feet behind crane shown.



Second locomotive unit, stopped on track No. 1. Arrow points toward location where first unit stopped down hillside on left of track No. 2.

The second car, a box car loaded with canned fruit, also overturned to the right on track No. 2 and stopped upside down on and in line with the structure of track No. 1, which was displaced to the south. Its front end stopped about 10 feet short of the east end of Curve 389.

The first car, an empty tank car, derailed and overturned to the right. It stopped on its right side with the rear end on the displaced structure of track No. 1 at a point about 10 feet ahead of the second car and on the west end of the short tangent between Curves 389 and 390. Its front end stopped between the displaced main tracks in the short tangent, and against the rear of the fourth locomotive unit.

The fourth locomotive unit derailed to the right and stopped on its right side between and parallel to tracks No. 2 and No. 1, which were displaced to the north and south, respectively. It came to rest with its rear end in the short tangent and its front end 16 feet into Curve 390.

The third unit stopped between the displaced main track structures in Curve 390, at a point 36 feet ahead of the fourth unit and in the same attitude as that unit.

The second unit stopped on its right side on and in line with the structure of track No. 1, at a point in Curve 390 about 235 feet ahead of the second unit.

After derailling, the first locomotive unit moved tangentially off the north, or left, side of the structure of track No. 2 in Curve 390, at a point about 380 feet east of the west end of the curve. It overturned onto its left side and slid down the hillside north of the main tracks. It stopped on its left side, about 120 feet north of track No. 2 and 150 feet east of the second unit.

All four locomotive units and four cars were heavily damaged.

Tracks No. 2 and No. 1 were destroyed or heavily damaged throughout distances of about 200 and 750 feet, respectively.

Damage Cost

The cost of damages to the locomotive units, cars, and track structures was \$512,100, according to the carrier's estimate.

Casualties

The front brakeman sustained sprains, abrasions, and contusions about his body.

The engineer was killed as a result of jumping or being thrown from the right, or south, side of the first locomotive unit just before that unit moved tangentially off the north side of track No. 2 in Curve 390. He was crushed under the second unit as that unit slid along the south side of track No. 2 after derailling and overturning.

Crew Members Hours of Service

At the time of the accident, the engineer had been on duty 7 hours 30 minutes and the other crew members 7 hours 15 minutes, after having been off duty more than 20 hours.

Normal Operating Procedure

According to officials and enginemen of the carrier, it would be normal procedure for the engineman of an eastbound freight train ready to leave Norden to apply power for starting the train on the level grade at Norden, and for increasing speed to about 20 m.p.h. nearing Tunnel 41 and the heavy

descending grade beginning in the tunnel area. He would then shut off power and apply the locomotive dynamic brake, using the throttle to control the strength of the dynamic braking on the descending grade.

Front Brakeman and Engineer

The front brakeman, age 60, had been employed by the carrier as a brakeman since September 1945.

The engineer, age 66, was first employed as a fireman in November 1944. He was promoted to engineer in June 1955. His record as an engineer was clear.

In 1966, a carrier's physical examination revealed that the engineer had a high blood sugar count. After spending two weeks in a hospital for treatment of this condition, he returned to service and thereafter underwent yearly physical examinations by the carrier. The last one was in December 1970. Records of those examinations do not indicate that a high blood sugar count was disclosed. The investigation revealed, however, that the engineer had been visiting a private doctor.

According to the private doctor, the engineer was last examined by him in November 1970 and was found to be overweight. In addition, tests revealed the engineer had a high blood sugar count, indicating a diabetic condition. The private doctor said he prescribed a diet for the overweight condition and Orinase as medication for the diabetic condition. It was the doctor's opinion that the engineer, with a weight problem and a physical condition which was very hard for him to accept, placed in a position of excitement brought on by unusual conditions, may have suffered a period of unconsciousness or a lack of ability to react.

The front brakeman said that while en route from Roseville, he mentioned to the engineer that he appeared to have lost weight since the last time they worked together. He said the engineer responded to this by saying he "had not been feeling too well for some time."

Three bottles of medication were found in the engineer's belongings after the accident. They were labeled as follows:

- | | | | |
|-----|-----------|----------------------------|-----------------------|
| (a) | EMP-C-COD | Every four hours for pain. | Prescribed
3/8/71 |
| (b) | VCILLINK | 1 tablet 3 times per day | Prescribed
2/9/71 |
| (c) | ORINASE | 1 tablet 3 times per day | Prescribed
1/28/71 |

According to expert medical opinion, the first bottle apparently contained Empirin Codeine, which may be prescribed to suppress pain from an infection. The second bottle apparently contained a form of penicillin, which may be prescribed to treat an infection. The third bottle apparently contained Orinase, a medication for treatment of a diabetic condition.

In view of statements made by the engineer's private doctor and the nature of the medication shown in the foregoing, it is apparent the engineer not only had a diabetic condition, but some type of infection as well. According to expert medical opinion, an infection can readily aggravate a diabetic condition, and this together with his consumption of the combination of medicines shown in the foregoing presented a considerable risk that the engineer could become physically incapacitated at any time.

Post-Accident Examinations and Tests

Fifth Car of Train

This was a 50-foot box car with a Hydra-Cushion sliding center sill and type E straight shank coupler. The center sill broke behind the coupler cross key slot at the front of the car. Approximately one-third of the break indicated that the center sill had been in a weakened condition for a considerable period of time before the day of the accident.

Fourth Car of Train

The air hose at the rear of the fourth car had a cut about one inch in length, possibly as a result of the derailment. It was later installed at the rear of the fourth car of a test train similar to the train involved in the accident. Tests revealed that despite a heavy exhaust of air from the cut air hose, the pressure maintaining feature and compressors of the locomotive were able to overcome the loss of air from the train line, and brake application and release from the automatic brake valve were not affected significantly.

Air Brakes

Examinations and tests revealed nothing which would indicate that a defective condition of the air brakes on the locomotive and four cars was a causal factor in the accident. The wheels of the locomotive and four cars were discolored and the brake shoes were heavily worn, completely worn out, or melted as a result of heavy braking action over a considerable distance, indicating that the air brake system of the locomotive and four cars was functioning properly.

Locomotive Control Positions

Although the first locomotive unit was heavily damaged, the interior of its cab did not appear to be damaged to the extent that the positions of the controls and switches therein were affected by the derailment. The throttle was found in No. 8 position; the reverser lever in forward position; the selector lever in power position No. 1; the automatic brake valve in emergency position; the independent brake valve in full application position; the switches controlling the dynamic brake circuit breaker in "On" position, and the generator field switch, control and fuel pump switch, and engine run switch all in "On" position.

The lamp which provides illumination for seeing the throttle and selector position indications through a window in the panel of the control stand was found to be inoperative because of an open filament. Other lamps of the control-stand panel were found operative.

The controls and switches of the trailing units were found to be in proper positions, except for the following: The engine run switch, generator field switch, and control and fuel pump switch of the second unit were found in "On" position, and the dynamic brake circuit breakers of the third and fourth units were found in "On" position. The reverser lever of each trailing unit had been removed, however. This should have nullified the effect of the aforesaid improperly-positioned switches.

Locomotive Dynamic Brake Equipment

Except for a disconnected circuit which adversely affected the extended range feature of the dynamic brake equipment, examinations and tests revealed nothing that would indicate the locomotive's dynamic brake system was in other than good operating condition on the day of the accident. This finding is somewhat inconclusive, however, as some electrical circuits could not be tested because of damages.

PC (Pneumatic Control) Switch

Inasmuch as the locomotive with four cars evidently moved under power after the emergency brake application caused by separation of the train, numerous tests were conducted under various conditions to determine the reliability of the PC switch to perform its function (automatically shut off power to the locomotive) when an emergency brake application occurs. For the tests, numerous diesel-electric units similar to those involved in the accident were used in three- and four-unit locomotive consists coupled to four cars. Each test unit had 26L air brake equipment with a Brake Pipe Flow Indicator, an A-1 Charging Cut-Off Pilot Valve, and an A-19 Flow Indicator Adaptor containing a 19/64 inch choke and a spring-loaded check valve for bypassing the choke and assisting in charging a fully depleted brake pipe.

Extensive testing brought to light the following two unfavorable conditions:

1. Unintentional Reset of PC Switch. - After being actuated by an emergency brake application, the PC switch on one leading unit of a test locomotive reset itself in about thirty seconds without the engineman having taken the action normally required to reset the switch, i.e. recover control of the air brakes and move the throttle to "Idle" position. This condition occurred as the result of check valve leakage which caused the A-1 Charging Cut-Off Pilot Valve to reset prematurely and thereby restore the PC circuits to running position.

Further testing with the aforesaid test locomotive also found that if the engine run switch, generator field switch, and control and fuel pump switch of a trailing unit are in "On" position (with the reverser lever of that unit removed as in the case of the second locomotive unit involved in the accident) and certain electrical control contacts of that unit are short circuited, the throttle of the first unit had no control over the engines of the locomotive after power was restored to the locomotive by the PC switch prematurely resetting itself as described in the foregoing.

It appears this condition can be averted by cleaning the double check valve of the A-1 Charging Cut-Off Pilot Valve piping at shorter periodic intervals, and by testing locomotive air brake equipment before departure from engine terminals to determine that the PC switch does not reset itself after an emergency brake application without appropriate action having been taken by the engineman.

2. Failure of PC Switch to Function. - If the automatic brake valve is placed in release position after a reduction of brake pipe pressure to 50 psi or less and an emergency brake application is initiated from the train line brake pipe within the following few seconds, the PC switch does not function (automatically shut off locomotive power) with any great degree of reliability, due to the heavy flow of air from the locomotive's brake valve into the brake pipe interfering with or completely blocking transmission of brake pipe pressure reduction at an emergency rate to the actuating piston of the A-1 Charging Cut-Off Pilot Valve.

Extensive testing revealed the reliability of the PC function can be substantially improved by (1) providing the spring-loaded check valve of the A-19 Flow Indicator Adaptor with a heavier spring, so that the valve will close at a lower value of differential or, on those locomotives not equipped with Flow Indicators, installing a 19/64 inch diameter orifice in the main reservoir supply to the brake valve, thereby limiting the critical by-pass interval and the undesirable heavy flow of air from the feed valve to the brake pipe (2) applying a softer spring on the actuating piston of the A-1 Charging Cut-Off Pilot Valve, so that a PC function can be obtained at brake pipe pressures as low as approximately 40 psi (3) relocating the No. 1 pipe connection from the A-1 Charging Cut-Off Pilot Valve arrangements to a connection in the branch pipe between the brake pipe and vent valve, (4) increasing the size of said pipe connection to insure inside diameter of not less than that of a 3/8 inch standard iron pipe, and (5) installing a vent valve in the brake pipe near the long hood end of such units (in addition to the vent valve now located near the short hood end) to insure transmission of the emergency rate of pressure reduction through the brake pipe when a long hood end is next to a car, or when two long hood ends are coupled together.

Analysis

This accident is somewhat complex because of the lack of definitive information relative to the engineer's manipulation of the locomotive controls after departure from Norden. Consequently, the events leading to the accident cannot be reconstructed with full assurance that such was the case. It appears, however, the sequence of events may have been as follows:

After the train entered the heavy descending grade and Tunnel 41 at a normal speed of 20 to 25 m.p.h., the engineer sought to put the locomotive in dynamic braking (in accordance with normal procedure) but inadvertently neglected to move the selector to "B" position as required for dynamic braking. This failure may have been partially due to confusion arising from the engineer's inability to see what position the selector was in because of the lamp of the selector indicator being burned out. The engineer apparently thought the selector was in "B" position and moved the throttle to No. 8 position to fully apply the dynamic brake. That action would have caused full power to be applied to the locomotive instead, due to the selector having been inadvertently left in a power position (apparently No. 1). As a result, the train increased its rate of acceleration on the heavy descending grade in Tunnel 41. Shortly thereafter, realizing something was wrong, the engineer initiated a heavy service application of the air brakes that subsequently stopped the train after it had partially emerged from the tunnel.

The engineer apparently neither reduced power in accordance with normal procedure as the train decelerated from the heavy brake application nor moved the throttle to "Idle" position when the train came to a stop. Instead, the throttle was apparently left in No. 8, or full power, position. Because of full power being applied to the locomotive after the train stopped and a weak condition of the sliding sill at the front of the fifth car, the train broke-in-two between the fourth and fifth cars, causing all the air brakes of the train to apply in emergency, including those of the locomotive and first four cars.

The emergency brake application should have caused the PC switch of the first locomotive unit to function and automatically shut off power to all the engines of the locomotive, i.e. reduce speed of all engines to "Idle". In view of the unfavorable conditions disclosed by post-accident tests, this may or may not have occurred, depending on whether the engineer moved the automatic brake valve to release position immediately before the emergency brake application occurred. Considering what took place subsequently, the PC switch evidently either did not function to shut off locomotive power, or functioned as intended but reset itself automatically in about 30 seconds and thus restored full power to the locomotive without the engineer having taken any action toward that end. As a result of one of the aforesaid conditions involving the PC switch, and of the throttle having been left in No. 8 position, the locomotive with four cars proceeded eastward

on the descending grade under full power after separating from the train. The air brakes of the locomotive units and four cars were applied in emergency, but their ability to stop the movement was overcome by the full application of power to the locomotive on a heavy descending grade. The emergency brake application, however, was somewhat effective in retarding acceleration of the locomotive and four cars until that equipment reached a point a short distance from the derailment area.

After the locomotive and four cars separated from the train, the engineer apparently moved the automatic and independent brake valves to emergency and full application positions, respectively. Those actions indicate he was somewhat aware of the situation, but they had no significant affect as the brakes of the locomotive and four cars were already applied in emergency.

Since the throttle was found in No. 8 position after the accident, the indications are that the engineer took no action to move the throttle to "Idle" position, apparently because of incapacitation. However, in the light of results from some post-accident tests, a possibility exists that he moved the throttle to "Idle" position and returned it to No. 8 position for an unknown reason after finding that the throttle had no control over the engines of the locomotive. It is noted, though, that the investigation disclosed no evidence of a combination of grounds and/or short circuits in the locomotive's electrical control system having adversely affected throttle control of the engineer. If this combination existed, the engineer had three ways to shut off power (other than by use of the throttle) readily available to him in the cab of the first locomotive unit. That the engineer, an experienced and knowledgeable engineman, did not take action readily available to him for shutting off power during the approximately eight-or nine-minute period in which the locomotive and four cars moved on the descending grade prior to their derailment could be considered prima facie evidence that he was incapacitated from his diabetic condition and was unable to react properly to the existing conditions.

The front brakeman, who was reputed to have considerable knowledge of the operation of diesel-electric units, evidently did not recognize that the engineer was incapacitated and therefore made no effort to take over the controls before he jumped from the locomotive.

The locomotive with four cars evidently remained under full power after the front brakeman jumped to safety. The emergency brake application was effective in retarding the speed for a considerable distance, permitting the locomotive and four cars to negotiate several curves, including sharp Curves No. 376 and No. 385. After this equipment negotiated the latter curve, the brake application became ineffective due to deterioration of the brake shoes by friction over a considerable distance. As a result, the locomotive and cars accelerated rapidly while approaching Curve 389 within a distance of approximately 1.3 miles and derailed after entering that curve, because of their excessive speed.

Findings

1. After the train entered a heavy descending grade and Tunnel 41, the engineer sought to put the locomotive in dynamic braking. Apparently due to not completing the proper procedure, the engineer failed to obtain dynamic braking, resulting in the train continuing forward with the locomotive under full power. Realizing something was amiss, the engineer initiated a heavy service application of the air brakes that stopped the train.

2. Shortly before or after he initiated the service brake application, the engineer became incapacitated perhaps because of some medication or combination of medications. Consequently, the throttle was left in No. 8 or full power position as the train reduced speed and came to a stop.

3. Because of full power being applied to the locomotive after the train stopped, and a weak condition of the sliding sill at the front of the fifth car, the train separated between the fourth and fifth cars, resulting in an emergency air brake application.

4. The PC switch of the first locomotive unit did not function as intended when the emergency brake application occurred. Thus, the locomotive remained under full power or had full power restored to it undesirably after the train separation and emergency brake application occurred. Due to full power being applied to the locomotive units, the emergency brake application was unable to prevent the locomotive with four cars from proceeding forward on the descending grade.

5. Apparently due to physical incapacitation, the engineer was unable to undertake any one of several ways open to him to shut off power to the locomotive and permit the emergency brake application to stop the movement. Apparently not recognizing that the engineer was incapacitated, the front brakeman made no attempt to take over the locomotive controls.

6. The emergency brake application retarded acceleration of the locomotive and four cars, permitting them to negotiate several curves on the descending grade. However, after approximately eight minutes elapsed, it lost virtually all effectiveness due to deterioration of the brake shoes by heavy braking action over a considerable distance. As a result, the locomotive with four cars then accelerated rapidly on the descending grade and derailed after entering Curve 389, due to excessive speed.

7. Post-accident tests revealed serious deficiencies in the capability of a PC system to function as intended under certain conditions. The Southern Pacific Transportation Company recognized the import of these revelations and promptly instituted a program for making the modifications necessary to eliminate these deficiencies on its locomotive units. The Federal Railroad Administration, in cooperation

with the Association of American Railroads, locomotive manufacturers, and air-brake equipment manufacturers, has taken appropriate action toward correction of the aforesaid deficiencies on a nation-wide basis.

8. The primary causal factor in the accident was inability of the engineer to shut off power to the locomotive apparently due to physical incapacitation resulting from a diabetic condition and/or medication. Contributing factors were (a) the engineer's failure to put the locomotive in dynamic braking when the train entered the descending grade, and (b) failure of the PC system of the first locomotive unit to function.

Dated at Washington, D. C., this 17th
day of March 1972
By the Federal Railroad Administration

Mac E. Rogers
Associate Administrator
for Safety

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FEDERAL RAILROAD ADMINISTRATION
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